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TECHNOLOGY, OR THE SCIENCE OF INDUSTRIES

By J. W. POWELL

INTRODUCTION

An industry is an activity whose immediate motive is the production of welfare for self and others. The term welfare has various meanings, but here we use it as signifying welfare of life—not esthetic, moral, expressional, or mental welfare. An industry by this definition means an activity exercised to promote life. We must remember that in this discussion, which is meant to be scientific, whether it succeeds or not, the term *industry* is used in this sense and in no other.

We use *activities* as a generic term including five species: esthetics, industries, institutions, expressions, and instructions. In this paper we are to consider industries.

Technology is the science of industries. An industry is an activity whose purpose is welfare or livelihood. We must here make clear the distinction between esthetic activity and industrial activity. The maid dances for the pleasure of herself or of others. If she dances for others it is a pleasure for them, though she may dance for gain, that is, welfare; still, it is an esthetic activity. A company of musicians make music for an audience; the audience pays for the entertainment. To the musicians the making of the music is an industrial activity, but to the audience it is an esthetic entertainment. Thus, whether an activity be designed for pleasure or for welfare will often depend on the point of view of the person interested therein.

The housewife prepares the meal for her own welfare and for the welfare of others. She may flavor the food to make it more palatable; the purpose of the condiment is thus pleasure; but the preparation of the food is still an industry, the secondary motive a pleasure. A feast is given for pleasure, but the food still sustains life; so pleasure and welfare are concomitant. In high civilization many activities are pursued for the pleasure of the people by persons who have welfare as their purpose.

Again, what is conducive to welfare may be productive of pleasure. The housewife in preparing the meal for welfare may have, and usually does have, these double motives. If we neglect the motive of welfare and act only from the consideration of pleasure, pleasure itself may be curtailed or pain may be produced. If the housewife, in catering to pleasure, uses condiments that are unwholesome, pain may be produced, and whether her act in compounding the cake be good or evil in effect will depend on whether she has considered both welfare and pleasure; only then do her acts become wise.

Motives are many and usually compound, and it requires no small degree of abstraction to discover the elements of motive even in self, while in others, whose minds are expressed in their acts, the task is still more difficult; for though the motive is best read in symbols of deeds, still, whether it be good or evil is often difficult to say. But every activity is performed for a purpose, and all demotic activities are performed for demotic purposes. We are now classifying activities as demotic activities; but in classifying them in this manner we must ever remember that altruism is founded on egoism and that a demotic activity has an individual effect on the doer. A man may play the violin for others in order to gain money with which to make a journey of pleasure; thus his motive may be immediate pleasure for others and remote pleasure for himself.

This is a concrete world, and abstractions do not exist in themselves, but only in human consideration as abstracts. Every abstract has its concomitants from which it cannot be dissevered, except in consideration. We may classify motives as motives for pleasure, welfare, peace, expression, and wisdom; and by abstraction we may consider any one of these motives, although they cannot exist apart. Every activity, when performed, involves all of the concomitant effects. The world is concrete, but the method of consideration is often abstract.

Industries are classified as substantiation, construction, mechanics, commerce, and medicine.

SUBSTANTIATION

Certain activities of welfare are fundamental thereto, because they are necessary to life. We must breathe air, we must drink water, we must eat food, we must seek shelter from the elements, and we must wear clothing. In the pursuit of these necessities of life, human activities are employed even in the primordial stage of savagery. Four of these necessary activities are pursued by the lower animals—they seek water, food, and shelter for their young and sometimes for their companions—but artificial clothing is not worn by them. Activities pursued for the welfare of self and others are industries.

The natural kinds fundamentally necessary to man are found by experience to be air, water, rocks, plants, and animals.

Air is necessary at every minute of life, and it is so abundant that man is not required to produce artificial air, though as civilization advances he finds it necessary to provide for its purity.

Water also is abundant. Man does not find it necessary to produce water from its elements, but he does find it necessary to produce it at the place where it is needed and to provide for its purity.

Minerals are found to be useful to man primarily, perhaps, for shelter; soon they are found useful as tools, and he engages in their production by quarrying and mining.

Plants are found to be useful to man as food in all its varieties, as sap, leaves, bark, roots, seeds, and fruits. Plants are also useful to man in providing shelter, and various parts of the plant are used in the construction of houses by human devices. Plants are also found useful to man in fibers as clothing.

Finally, animals are useful to man for food, shelter, clothing, and other purposes.

Thus, tribal man utilizes all of these kinds or natural substances, for which he especially develops the industries of quarrying (the simpler stage of mining) and agriculture for the production of natural plant products and natural animal products. Tribal man uses natural substances developed by natural chemistry; civilized man not only uses the natural substances, but he produces innumerable artificial substances by artificial chemistry.

The production of kinds or substances, whether natural or artificial, leads to the distinction which we are trying to make of the class of industries which we call fundamental industries. They are those in which men engage for the purpose of producing substances, whether they be natural or artificial. Fundamental industries may well be called substantial industries because they produce substances.

All industries are productive industries, and the product is consumed. Production is thus the correlative of consumption, and correlation must be distinguished from reciprocality and from antithesis. Reciprocality is the double consideration of a thing as a whole or as the parts of which it is composed; antithesis is the distinction between good and evil; correlation is the consideration of relation between terms, neither one of which can be expunged if the relation exists. This is the distinction we must make between producing kinds and producing forms. A man may produce apples by cultivation, when he produces a kind; when he produces cider from the apple he produces another kind or substance. A man may produce a flint by quarrying it, or he may produce it even by picking it up; he then produces a kind of rock; but when he makes the flint into a knife, he produces a form.

In tracing a series of transmutations from material to product, we may always reach a stage where the material is finally consumed or used. To use an unfamiliar but very useful term, borrowed from metaphysic, we may say that an entelechy is ultimately reached. The entelechy is the final end had in view by the exercise of an activity.

In tracing material through its transmutations from its original state to its final purpose, there arise a succession of correlations, the terms of which are known as production and consumption. How these terms are used will be made clear by a few illustrations: Primitive man produces flint from the quarry and consumes it in making the arrowheads which he produces. With his arrowheads he produces rabbits; thus his arrowheads are said to be consumed when they are lost or destroyed, but there is still the production of rabbits from the wold, and this production is consumed as food.

The farmer purchases a tract of land covered with forest. The forest land he converts into a field; the forest he consumes perhaps for fuel, and the fuel is the product which he consumes for welfare, and the entelechy is reached. The field remains from which he grows corn, and the year's production of the field is consumed; but the corn remains as a product, which is material for the miller, which he consumes as miller's material by grinding it, thus producing meal; the meal is baked by the housewife who consumes it as meal in producing bread, and the bread is eaten by the farmer's household and consumed, thus producing welfare, which is the entelechy.

The lumberman cuts logs in the forest; he consumes forest trees and produces logs; the raftsman consumes them at the place where they were produced, and delivers them at the mill as the product of his labor; the product is the log delivered at the mill. The log is material for the miller, out of which he produces lumber; logs are consumed and lumber produced. To the builder the product of the miller is material which the builder consumes in the product of his labor, which is a house; the domiciliary user consumes the house in welfare, and this welfare is the entelechy. Maybe the lumber is used for making furniture, then lumber is consumed and furniture is produced, and the furniture is consumed in the production of welfare, which is the entelechy.

The planter purchases a field on which he raises cotton; the time of the field, that is, its power of producing for a year, or, in other terms, the interest of the purchase money for the field for a year, is consumed in the production of a crop. The labor on the field is also consumed, and the field of cotton is produced. Then the cotton from the plant is picked, and the field of cotton is consumed by the picking of the cotton bolls; the cotton now becomes the material for another process. Overlooking minor operations, it becomes material for the spinner, who makes a product of yarn; the cotton and the labor employed are consumed by the man who makes a product of cloth. Then the tailor consumes it as cloth, together with an amount of labor necessary to make it into clothing; then the clothing is consumed by the wearer, when it reaches its entelechy. Thus land, by a series of human processes through intelligent labor, produces welfare through a series of changes in which labor is consumed.

In the course of production from one kind to another and from one form to another, the domain of nature and art is ransacked for the purpose—air, water, land, plants, and animals are utilized and a multitude of persons are employed.

In the consideration of production we must contemplate the natural material found in air, in sea, in land, in plants, and in animals. The air is ambient over all the surface of the earth as a hollow sphere of gas. The sea has its gulfs, bays, and straits, with its auxiliaries in springs, lakes, and rivers, while the lower portion of the air is laden with moisture which is partially gathered into clouds and precipitated on the earth in rain when favorable conditions prevail. Thus the water is a sphere of liquid which intervenes between air and land. The sea with its auxiliaries yields its materials and the air yields its materials. Plants are scattered over all the surface of the land not covered with liquid water, and over a part of the surface of the land which is covered with liquid water, and over a part of the surface of the water, while animals inhabit the atmosphere and the watery envelope or hydrosphere. What is usually called the land is but the upper surface of a third sphere of solid rock which is denominated by geologists as the lithosphere; this lithosphere contains another and important portion of the substances which are produced for the welfare of mankind. The lithosphere, the hydrosphere, and the atmosphere, together with the plants and animals of the earth, constitute the environment of mankind. All human industries are therefore included in the consideration of the sources of the substances which men produce.

Hence, when we classify the substances of the environment in these five groups, we classify them in coördinate groups from the consideration of the environment of man, though we may afterward subclassify every one of these groups. We are not classifying substances as fundamental classes, but we are classifying the substances used by man as fundamental classes, and the subclassification will still include only the substances used by man.

Man is a denizen of the air; he lives on that portion of the surface of the lithosphere which is called dry land, where the watery envelope is vapor. Thus he is directly connected in his environment with the three spheres and utilizes them for his purposes. Man is not content with thenatural products of the lithosphere, but he seeks to improve them. He is not content with the natural products of the hydrosphere, but he seeks to improve the water by purifying it or by charging it with other substances. He is not content to drink like the beast from the pool or the stream, but he seeks to bring the water to himself in the most convenient and best manner in which to enjoy it. Man is not even content with breathing the atmosphere, but he seeks to procure it in its purity, so he ventilates his habitation and otherwise secures the greatest purity. Man is not content with the plants as they are furnished by nature, so he improves them by cultivation and multiplies those which are useful to him and destroys those which are useless or injurious. Man is not content with the animals, so he improves them by zoöculture and he destroys the useless and the injurious.

To designate those industries in which men engage for the purpose of producing kinds or substances, we need a technical term which will distinguish them from all other industries; for this purpose I use the word *substantiation*, which must here mean the artificial production of substances for human welfare. I have sought long and far for the best term. I may not have chosen wisely, but I have chosen with all the wisdom of which I am possessed. It does not lie in the prerogative of another to reject my term when he attempts to understand my meaning, though it may be his prerogative to use another term when he desires to express the same meaning. If the distinction pointed out is a valid one, and useful for scientific purposes, a distinctive term is necessary; if the distinction is invalid or unfruitful to science, it may be neglected. Do not quarrel with me about my terms, but quarrel with me about my distinctions. If you decide that the distinctions are good, then accept my terms as they are used, still reserving the right to use better terms when you wish to set forth the same concepts.

In the transmutation of materials into products, the processes must be invented; but the product which is sought in manufacture may be but a small part of the material used. Metals are extracted from the ores, while the residuum is often valueless. Quinine is extracted from the bark of cinchona trees, and the product is very small compared with the trees. Sometimes secondary products are found still of value to mankind. From asphalt and other hydrocarbons illuminating products are manufactured, and from the substances which do not subserve this purpose aniline dyes are extracted. So by invention a multitude of substances are derived which serve human purposes. Forever by art, substances are multiplied and their manufacture specialized. (1) In modern culture man produces pure air by purifying it;

(2) he produces pure water by purifying it; (3) he produces various substances by mining and metallurgy and other chemic processes; (4) he produces plants by plant culture, and (5) he produces animals by zoöculture. Thus, the fundamental industries, which we here call industries of substantiation, are industries for the production of kinds.

CONSTRUCTION

The next class of industries in which men engage are those which are designed to modify the forms of things for use. Here we must call attention to the distinction which we make between *kind* and *form*. In popular usage these terms are interchangeable, but in science we must use terms with single meanings; this is a fundamental requirement. The failure to observe this law opens the door to idle and vain speculation. We may find an illustration of what is meant by kind in ordinary enumeration and in the devices which men have invented to represent numbers. We have ten units as a sum; the ten units constitute but one ten, twenty units constituting two tens, and a hundred units constituting ten tens. The ninety-ninth is but one of the units of a hundred; it is but one in the last unit of the second order which constitutes the hundred. Counting is fundamentally determination of kind; and counting, like classification, is first determining a kind and then seriating the kind to obtain the class. I wish to count the horses in the field, and I must first distinguish the horses from all other kinds in the field and then enumerate them. This is counting. But if I distinguish the kind of horse and include them all as horses, I thus include all of this kind in nature. The difference between counting and classifying exists solely in the nature of the series which we consider. I invariably use *kind* in this sense and in no other.

Form signifies figure and structure, and implies the relative position of the parts which make up the whole. This distinction which I make between kind and form must be held permanently.

You must not fall into the habit of confusing the terms as is done in common speech. In science we must use form to mean one thing and kind to mean another, and unless we adhere to this it is impossible to make scientific advance. Every man loves to use words as his neighbors use them, for speech is but a convention, and unless the convention is understood by others it is an unknown tongue; but no man has a right to demand of another that he use his words with the same meanings as himself if the other defines his meanings, and still less has he the right to demand that another should use a word with many meanings and thus obscure his language.

Man produces the clay when he digs up the kind of clay, or he may produce the kind of clay by mixing ingredients; but when he molds the clay into a brick he determines the form. He may mold the clay into a vessel, then he also determines the form in which it is useful.

Man produces forms of things that he may utilize air, water, rocks, plants, and animals. He utilizes air when he produces things that insure proper ventilation. A chimney is a form for this purpose; an opening in a room and a shaft in a building are forms of this character; a fan is a form designed to secure a better movement of the air.

For the utilization of water primitive man constructs a gourd into a drinking cup, or he molds clay for the purpose of holding water, or he constructs wicker-work jugs for this purpose; so man digs wells and constructs reservoirs, and lays pipes for the transportation of water, and in higher civilization he constructs filters for the purification of water. Thus, innumerable forms are constructed by man for the utilization of water.

In the same manner many forms are produced for the utilization of rock material. The rocks are built into houses as rock structures proper; the clays are molded into bricks or adobes to be built into houses. Iron is extracted from the rock and molded into innumerable forms for men's use. Copper, gold, and silver are in like manner produced as substances and wrought into forms which serve men's purposes for welfare.

Plants are used for fuel and wrought into forms that they may be utilized in stoves and furnaces. Plants are also wrought into forms of lumber and used in constructing forms of houses, furniture, vehicles, and ten thousand other shapes, that they may be useful to man; and many substances are extracted from plants to be wrought into forms. Many resins are used in this manner; indeed the productions of forms from the product of the rubber tree that are useful to man are too great for enumeration.

Time fails me to tell of the innumerable forms into which animal substances are wrought for the use of man. But animal substances and vegetal substances have their grand use as food. The forms into which they are converted before they reach the entelic use are innumerable, but the subject is so often illustrated in daily life that to call attention to the fact is all that is necessary to our purpose.

In the production of entelic forms many ancillary forms are produced. These, perhaps, are so apparent that they need no further illustration; but the forms which are produced by man through industrial processes that serve the entelic purpose of welfare are innumerable, and when we distinguish them it becomes necessary for us to group these industries under one term in order that they may properly be distinguished from the industries of substantiation and from others which we have yet to consider. I shall therefore call them the industries of *construction*, as that term seems best to convey the concept. In late years there has grown up in science the use of a term which clearly sets forth the nature of the products of construction as the term is here used. This is artifact; the products of construction are artifacts. Construction, therefore, is the industry of producing artifacts, just as substantiation is the industry of producing substances. As substantiation is the art of producing substances from air, water, rock, plant, and animal, so construction is the art of producing useful forms of artifacts from air, water, rock, plant, and animal.

Form and kind are concomitant. There can be no kind without form, and there can be no form without kind, and the distinction which we here make is but a distinction in consideration which classifies the industry. The world is concrete; but man's method of looking upon it is often abstract, and so his knowledge is ultimately built up into concepts of concrete things, which are first considered as abstract things when concepts of abstract things are utilized. All properties and qualities are abstract, but they inhere in concrete things. Concrete bodies and their abstracts as properties and qualities require abstract concepts for their cognition. Again must we recall the demonstrations of the pentalogic essentials of every particle of matter incorporated into the bodies of the universe. That there are five and only five of these essentials is the ultimate purpose of this discussion, and the ultimate demonstration must remain in view if we are to understand the nature of the argument.

MECHANICS

In classifying industries as those of substantiation or those of construction, we were compelled to use terms with specific meanings, and we selected the terms used because they seemed to be the most available for that purpose and because there seemed to be no terms in use for the industries which we wished to discriminate. Manufacture etymologically means " made by hand." In all industries the hands are used to a greater or less extent, and the term is used with this wider significance, so that its etymology and wider use alike forbid its employment to signify what we desire when we adopt the term construction. In the case of *mechanics* we have a term which is already used in science for the purpose we wish, signifying the industries which have for their purpose the utilization of powers.

The mechanical devices as forms which are employed in the utilization of powers are the hammer, the lever, the wedge, the wheel, and the pulley.

A hammer is a device for condensing the motion of a ponderable body through a space in a time and expending it in an instant; or it may be defined as the method of expending gathered momentum in the instant of impact.

A lever is an instrument which is used with a fulcrum to move a weight by taking advantage of the motion in an arc of a larger circle to the correlative arc of a smaller circle, so that the force of the long arm is expended in the short arm. A smaller mass is thus made to move a larger mass, but the smaller must move a greater distance. A hammer which is used for percussion is often supplied with a handle, which is a lever with a fulcrum in the edge of the hand. Thus the long arm of the lever is next to the hammer, and the momentum of the hammer is increased thereby.

A wedge is an inclined plane used to subdivide the distance of the weight moved into minute parts. The wedge itself is usually employed in conjunction with the hammer, the wedge being a device for subdividing the distance moved, and the hammer being used to take advantage of the force of percussion.

A wheel is a device for reducing friction, and the friction is reduced inversely as the perimeter of the wheel is enlarged over the perimeter of the axle. The wheel is variously modified for the reduction of friction.

A pulley is a succession of wheels so geared that the force applied must move over a greater space than the weight to which it is applied; hence a larger mass may be moved by a smaller, as in the case of the lever.

These forces—the hammer, the lever, the wedge, the wheel, and the pulley—are often combined in the same mechanism. Thus, in the screw, the lever and the wedge are combined, but the wedge is a spiral wedge. These fundamental mechanical devices are combined in a great variety of ways in the machinery of the industries.

These devices for applying power are sometimes called the mechanical powers, and the powers themselves are called forces, for they are devices to produce modes of motion.

Again I must remind the reader that there is no such thing as abstract power; it is always concrete, and its concomitants must always be considered when we consider real power as such. Power exists as an abstraction only in consideration.

Having considered the nature of powers, we have now to consider them as they are utilized in tools and machines. A tool may be defined as an implement employed to utilize human power. A machine may be defined as an implement employed for using any other power than that of human muscle. The tool is dependent on the hand and is adapted to the use of the hand, while the machine is adapted to the use of other powers than that of the hand, though these powers may be directly or indirectly controlled by the hand. A flint may be fashioned into a knife on a grindstone supported by a wooden horse; the grindstone is a tool, but it may be run by water-power, when it becomes a machine, for it must be provided with the apparatus necessary to utilize the fall of water. A hand-hammer is a tool; but a trip-hammer is a machine, for some other power than that of human muscle is used in its operation. The hand-dasher in a churn is a tool; a power dasher in our modern dairies is usually a machine. The flail is a tool used only by human power; the thresher is a machine in which horse-power or steam-power is employed.

In the multiplication of processes, which we have already illustrated somewhat, many machines are employed in the manufacture of a single class of products. Often these machines are housed for their protection and for the protection of the laborers who are operating them. Such a group of machines with their houses is called a mill or a factory. In the mill many machines may be used, and many tools, all designed for the common purpose of producing a class of objects.

It now remains for us to set forth the classes of powers which are used by men to promote their welfare. These are muscular power, wind-power, water-power, heat-power, and electric power.

Muscular power—This power is the primordial force used by mankind, first as human power, but in the second stage of human culture animals were domesticated and used as beasts of burden. Especially is one animal used for this purpose, namely, the horse, and the power of a horse for a definite period of time, established conventionally, has come to be used as the standard of measurement for powers. Animals are used not only for carrying and hauling burdens, but they are used also for impelling machinery.

Wind-power—Wind-power is used to propel machinery and especially in the navigation of water to propel vessels, and the machinery devised for the latter purpose consists of masts and sails. In the early history of civilization the propulsion of vessels and the running of mills were relatively much more common than at present, and yet this power is widely used. Since air has been liquefied it seems likely that this substance is to play a still more important role in mechanics, and air is to become a commodity.

Water-power—Water-power is used chiefly for the running of mills. The tides as they rise and fall are utilized in their onward rush to impel mills by the construction of the necessary machinery, and the fall of water in running streams is utilized for the same purpose. Water is used also as steam to connect heat-power with machinery.

Heat-power—This power is obtained from the combustion of plants and animals and the hydrocarbon products derived from them. Steam is but a medium through which heat-power is applied.

Electric power—Electric power is also a medium for transmitting wind-power, water-power, and heat-power; but it also seems to be an independent power itself. Not being a physicist I am not competent to properly discuss this subject.

This whole discussion of mechanics may be considered as exceedingly elementary and to be but a simple exposition of common knowledge. It serves the purpose of this discussion all the better for this fact, for we are trying to exhibit the nature of the activities in which men engage for the purpose of classifying them and discovering how five properties of matter and only five are recognized in these activities, and for the further purpose of showing how they lead to five classes of emotions.

COMMERCE

The fourth great class of industries in which men engage for the purpose of obtaining welfare is *commerce*. Men do not produce substances everyone for himself, but everyone for others. They do not produce constructions everyone for himself, but everyone for others. They do not produce powers everyone for himself, but they produce powers everyone for others. The production of substances, artifacts, and powers are designed for the consumption of others; they thus become the materials for exchange, which are then goods.

Goods are produced, as we have already seen, by substantiation, construction, and mechanics, and there are other agencies which we have not yet considered. These products pass from one person to another in exchange before they are consumed as an entelechy. Every exchange implies a production and a consumption until the entelic consumption is reached.

The five properties of matter give rise to five elements of commerce, which we must now set forth. The first element of commerce consists of the goods or kinds of things which are exchanged. The second element is transportation, which means the transfer of commodities from one person or place to another. The third element is the labor involved in making the exchanges. The fourth element involved is the money employed as the medium of exchange and measure of value. The fifth element employed is advertising, which is the method of informing those who desire goods for consumption that others have them and offer them in exchange for money. The five elements of commerce, therefore, are goods, transportation, merchandizing, money, and advertising. Every one of these elements of commerce involves activities—the activities of producing goods, the activities of transportation, the activities of exchange, the activities of finance, and the activities of advertising. They follow in this order from the nature of qualities which are derived from properties. Nature has established the order in which properties must be considered, for Nature herself considers them in this order. Now we have to consider the five elements of commerce severally for the purpose of considering the elements of which they are composed.

Goods—Goods are classified as esthetic, industrial, social, linguistic, and instructional.

Esthetic goods are ambrosial, decorative, athletic, gaming, and fine-art goods. These may all be reclassified in five groups. We have already seen [1] how the fine-arts may be classified, giving rise to goods which are musical, graphic, dramatic, romantic, and poetical. In the same manner industrial, social, linguistic, and instructional goods may be classified and reclassified. Every value which man produces becomes goods, for in its production he expends activity, which is labor, and receives in return for his labor the goods which he desires. In modern society the goods are obtained through an intermediate commodity—money—which is the measure of value and instrument of exchange.

Transportation—As men produce not for themselves but for others, and receive money in exchange which they expend for themselves, the things which they produce must be transported to the others. A man may produce an article which his next-door neighbor uses, and the transportation from one to the other is but an inconsiderable item. But the production may be a hundred or a thousand miles away; then the transportation becomes an important element in commerce; hence ships and railroads are constructed, and large bodies of men are employed in these industries. At first thought these industries along the great highways seem to absorb our whole attention, but on more minute consideration we find that the transportation of commodities for short distances is no inconsiderable item. Thus, the transportation of the bread, milk, and other items of trade through the streets of the city and the highways of the country, from the marts of trade to the individuals who are the entelic consumers, is of much relative importance. The transportation of commodities altogether will be found almost to vie in importance with the production of commodities by substantiation or construction or mechanism. We find that all of these operations are concomitant.

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[1] *Esthetology, or the Science of Activities Designed to Give Pleasure* (AMERICAN ANTHROPOLOGIST, n. s., vol. I, p. 16).

To the carrier, goods transported become freight. Goods and freight, therefore, are the same thing from different standpoints of consideration. In transportation we have to consider not only the freight but the substances, the constructions, and the powers employed in freighting, as well as the persons who direct the operations.

We must notice the correlation involved in transportation. In every transaction which involves transportation there is a producer and a consumer, and each party is both. The man who produces wheat is the consumer of the goods for which he exchanges wheat, so that there is correlative transportation. But the subject of correlation is to some extent masked through the employment of money as a medium of exchange, for as goods are not exchanged directly, the correlation of transportation is in the first step the transporting of money in one direction and the transporting of goods in the other. When credits are used as symbols of money, the correlation is still further masked, and wherever a man may be he has demands which must be supplied. These demands must be transported to him, because he lives on the goods produced by other men which must be transported to him. The ultimate correlation is dependent on the equity of transactions.

There is still another phase of transportation that must be mentioned without stopping to fully set forth its nature. A man's wants may be supplied by transporting supplies to himself, or they may be supplied by transporting himself to them. No inconsiderable part of transportation is employed in transferring individuals themselves.

The substances that are employed in transportation are air, water, rocks, plants, and animals. The constructions that are employed in transportation are (1) those which are designed to utilize the air, such as ships that are impelled by sails and pneumatic tubes which are utilized by air pressure; (2) those constructions which are employed to utilize water for transportation, such as the steam-engine and that machinery by which material is transported from one part of the mill to another by water-power; (3) those which are employed to utilize wood, or coal (which is fossilized wood), for transportation; (4) those appliances which are necessary to utilize animal muscles for transportation, such as saddles, common road vehicles, and all of those articles which have become necessary when human beings transport freight; (5) all of the tools and machinery which are employed in the utilization of electricity for transportation.

Exchange or Merchandizing—The man whose industry is buying and selling goods is the exchanger, and he regards goods or freight as commodities. Goods or freight thus become commodities to him, but the merchant has to buy his commodities instead of to manufacture them. The industry of merchandizing is therefore distinct from the industry of transportation, as the merchant is also distinct from that of the mechanician who produces useful powers, or from the constructor who produces useful forms, or from the industry of the man who produces useful substances. The elements of merchandizing are buying, storing, exchanging, delivering, and gaining. In buying, the merchant must consider the wants of the people ; in storing, he must consider preservation of the goods ; in exchanging, he must consider the value of the goods ; in delivering, he must consider the distribution of the goods to his customers ; and in considering gains he must consider the total cost to himself and compare it with the amount received, which may show profit or loss.

Money—This leads us to the fourth element of commerce, *i. e.*, money, which, as one of the commodities, has to be considered as a value in relation to the other commodities, which are goods. Money consists of gold, silver, subsidiary coins, bank-notes, and credits. In different stages of culture different articles have been used as money, such as shells, wampum, peltries, tobacco, and cattle ; but in modern civilization the five kinds of money are almost universal.

It has already been considered important that the value of money should be permanent, so far as this can be secured by human agencies. If we consider long periods of time, this has never been accomplished. The device which the more advanced nations have adopted is to make either gold or silver or both, at a fixed ratio, the measure of value, and then by statute to provide that subsidiary coins should be issued by the government. It is provided further that bank-notes should be made exchangeable with coin at the option of the holder who presents them for payment ; but in modern times credits are very largely used in transactions, so that much of the money used in commerce is of this nature.

The business of the banker is the handling of money for a profit. He must therefore be a capitalist—must have money of his own,—and the amount of money or credit of others which he handles, other things being equal, will depend on the amount of capital which he has invested either directly in banking or as security which it affords to the public in his transactions. In modern business much is transacted by credits, which are a kind of money, and the capital of the banker is held by his customers as either moral or legal security to them. The business man deposits money with the banker and draws it out on check from time to time as he uses it. A banker, having the deposits of many men, finds that he has in his custody a surplus of money which is more or less constant. This surplus he lends at interest; he also lends his own money; his profits, therefore, come from the lending of money—either his own or the money deposited. The banker lends money to the public, but he is especially a lender of money to his depositors; thus, a merchant may deposit money by giving his note bearing interest, against which he draws by check.

Advertising—This leads us to the fifth element of commerce, which is advertising. In advertising, that which was first considered as goods, then as freight, then as commodity, then as value, is now considered as want. The merchant's business is to supply want, and it becomes necessary for him to inform the public of the goods which he offers for their supply. The method of giving this information to the people is advertising. The primal method of advertising is by the display of the goods themselves by the merchant or his assistants; no small proportion of the time of the salesmen is occupied in displaying goods to purchasers. The second method of advertising is by the display of goods in conspicuous places, especially in show-windows; this method of advertising has now become well-nigh universal; show-cases and window-cases are arranged with deft hands in order to make goods attractive. The third method of advertising is with post-bills, which are placed in conspicuous positions—on the walls of buildings, on fences, and by the wayside, or worn on the backs of men. The fourth method of advertising is by the distribution, through carriers or by the mails, of hand-bills, which are designed to inform the public of the character and prices of the goods offered for sale. The fifth method of advertising is the insertion of such business announcements in books and periodicals. Much of the advertising is now absorbed by the periodicals; the daily, weekly, monthly, and quarterly journals are to a large extent supported by advertisers who display in type the goods offered for sale, but the journals themselves are introduced to the public by the publication of news and the discussion of current topics, all of which are desired by the people.

MEDICINE

We have now to consider an industry which is designed to secure welfare for mankind in preventing, alleviating, and curing the diseases or other injuries to which men are subject. This industry is founded on the importance of securing the best opinions of men especially trained in the learning which pertains to sanitation and the remedies which are discovered to alleviate and cure diseases; it is especially an industry of opinions. Formerly this feature of the industry was somewhat masked by the more or less constant habit of medical men to furnish the medicines and appliances which they use, and to charge for the same rather than for their opinions. But an industry has been differentiated from medicine proper and is relegated to the apothecary who supplies, as merchandise, the medicines and appliances, and the merchant obtains them from manufacturers who produce constructions and substances.

Here we have to note a peculiar habit of language by which the industry of medicine is called a profession. It will be observed that those persons who engage in the highest form of esthetic art, which we have called the fine-arts, and who make a business of producing kinds of pleasure for others, are called professionals. In general, a professional is one who claims to be such an expert in his industry that he can command welfare for himself by the production of an esthetic commodity. We might stop here to show how the lawyer or the judge is also called a professional, but it will be sufficient for us to notice that the term is applied in common usage to denote a high degree of excellence in an industry, and that it usually pertains to those persons who engage in the fifth grade of arts, as we have designated them, namely, esthetics, industries, institutions, linguistics, and opinions. In medicine, the professional medical man is remunerated, not for the medicine which he furnishes, but for the opinion which he gives.

Thus, in the order of arts which depend upon the properties, the fifth property of consciousness gives rise to a fifth industry of welfare, which we call *medicine.*

The subject of medicine is fundamentally controlled by the five properties of human bodies and the organs which are developed severally for these properties. These are (1) the organs of metabolism or animal chemistry; (2) the organs of circulation or animal construction; (3) the organs of activity or animal locomotion; (4) the organs of hereditary genesis or reproduction, and (5) the organs of the mind or the nervous system. In order that the opinions of the medical man shall be of value, he must acquire a knowledge of the metabolic, constructive, muscular, reproductive, and nervous systems of the human body. This is fundamental.

Here it may be well to call attention to the organs of circulation in order to show that they are organs of construction, though motion is involved therein; for the properties are always concomitant. But when we consider circulation, we are considering it as the placement of the erythrocytes which are brought to the parts where they enter into construction. We are not considering the power by which circulation is accomplished, nor are we considering the motion of the particles as trajectories, but we are considering the constructive result which arises therefrom, together with the result which is produced in removing waste material. We are not considering how the removal is accomplished, but the results of the accomplishment.

For the sanitary knowledge which he must obtain, the medical man must acquire a knowledge of the substances which men use in continuing life on this planet—air, water, rocks, plants, and animals,—and how they are kept pure from deleterious substances or conditions. This function of the medical man is of modern origin, and belongs solely to the scientific period of medicine. We have to thank the medical profession for a vast body of scientific knowledge relating to this subject. It is the glory of the profession that its most arduous labors, its greatest scientific discoveries, and its most enthusiastic pursuits are devoted to sanitation.

Remedial medicine has a long and interesting history. We have already seen, in the account given of Esthetology, how the fine-arts are involved in the superstitions of mankind when they also play an important role in the religions of the world. Now we have to see how these superstitions control the practice of remedial medicine. In every early society there is used a word which has the significance of "priest" as well as "doctor." The word "shaman" has come to be used as the representative of such words. We have already seen how esthetology was emancipated from religion. We must now set forth how medicine was emancipated from religion, for in the earlier stages of culture, when the opinions of mankind were mostly superstitions, religion essayed to control all human activities, and the priest was the dictator in every field of life; especially was it true of all those tribal and national organizations in which the head of the ecclesiastical body was also the head of the political body, and thus church and state were one. How this state of affairs originated we cannot here set forth in any adequate manner, but we are compelled to refer to it in treating of the subject of medicine, and to make a brief characterization of the nature of early remedies.

Here we must set forth the doctrine of what I shall call *imputation*. Imputation is the practice of attributing effects to erroneous causes, as when I impute the pain which I feel in my head to a spell which has been wrought upon me by a witch. A superstition is an opinion which a man may hold by reason of imputation.

Now, we are briefly to consider how this practice originated. Savage men always impute mind, or organized consciousness, to inanimate things, such as plants, rocks, the phenomena of water, and phenomena of the atmosphere. They also impute mind to the heavenly bodies, which they suppose to be molar bodies in the tent of the sky, which to them is the great wigwam of this world. If the savage strikes his foot against a rock and seriously wounds himself, he fails to attribute the accident to his own carelessness, but he imputes it to the rock itself, as being designed by the rock in order to injure him. Thus motives are assigned to all inanimate things, and events are brought about by others, animate or inanimate, which in fact are due to this activity. This is the fundamental phase of imputation.

Then tribal men believe that mind, which is a property of animal bodies, is a property of all bodies, and that this property is not a concomitant of the body and inherent in the body itself, but that mind is independent of body and can live apart from it, and when the mind leaves one body another mind may take up its residence there. This is the doctrine of ghosts as free, independent, and wandering minds.

There are many phenomena which to the savage mind lead to this opinion. I may briefly mention them: The phenomena of dreams, where men seem to go out of their own bodies and wander about the earth; the phenomena of ecstasy, produced by excessive mental or physical activity, where men seem to have visions of other times and places or to hear voices which do not speak in their ears; the phenomena of hypnotism, where men seem to see scenes which are not naturally presented to the hypnotized person; the phenomena of intoxication, where men believe they observe that which bystanders know to be not true; the phenomena of insanity, where the diseased person has thoughts which are erroneous, in which cases the savage believes that the ghost of another has taken possession of the invalid. The doctrines derived from these sources seem to be confirmed to the savage mind by the phenomena of shadows and especially of echoes. Hence, in tribal society a ghost life is held in universal belief. Thus to imputation is added the ghost theory, or spiritism.

The savage man imputes the diseases which afflict mankind not to the bodies with which he peoples the world with animal creatures, but to the ghosts of these bodies. Hence we often find in a savage tribe that diseases are classified in a more or less vague way as the diseases of the stars, the diseases of the waters, the diseases of the rocks, the diseases of plants, and the diseases of animals. He does not consciously classify them in this manner, but he imputes them to the ghosts of these objects. When a patient is examined by the medicine-man, he may affirm that he has the elk disease, the bear disease, the wolf disease, the rattlesnake disease, or the green-snake disease, or he may say that he has the spider disease, or the fly disease. Especially are animals selected as the authors of ailments. I once witnessed the treatment of a child by an Indian shaman who claimed that its ailment was due to a little fossil abundantly found in the carboniferous rocks of Colorado, and known as *Athyris subtilita.* I have many times known colds to be attributed to insects, toothache to be attributed to worms, rheumatism to be attributed to snakes, fevers to be attributed to birds; but on careful examination I have often found that the bodies of these things were not held to be the authors of the mischief, but that their ghosts were the active agencies. Not always can this explanation be obtained, and sometimes the thing itself will be exhibited as having been extracted from the patient; but, in the case of the *Athyris*, the medicine-man claimed to me that, when he extracted the disease from the child, he put the fossil in his mouth before he performed the act of suction by which the ghost was extracted, and that his office consisted in extracting the ghost from the child and returning it again to the body of the fossil.

It may be worth while for me to state how widely prevalent is this doctrine of disease among the North American Indians. I have found it myself among many of the Shoshonean tribes, which occupy a large area in the western portion of the United States; I have found it among the Wintun of California and many other tribes of the Pacific slope; I have found it also among the tribes of the Gulf states, and have never failed to find instances in any tribe among whom I have made diligent inquiry. Such causes for disease, however abundant they may be, must not be considered to be universal as they appear to the savage mind. The tribes of America rather seem to prefer to ascribe their evils to their enemies within the tribe, or still more often to their enemies in other tribes, when of course they believe in witchcraft. Especially are epidemics imputed to hostile tribes. The theory of the action of their enemies seems to be somewhat of this nature: that the shamans of the enemies have control over disease ghosts. But enough of this phase of the matter here.

In barbarism, which is the upper stage of tribal society, the theory of disease undergoes marked development; not that imputation is abandoned, not that ghosts play a less important role, but that a new group of mythologic beings is developed. These mystic personages are personified phenomena of nature which exist as divine personages, partaking in the affairs of mankind. While the hosts of savage mythology still exist in the popular mind, the leaders lay more stress on the doings of these nature gods. The nature gods are not supposed to be pure spirits, and to have a celestial home where they habitually dwell and where they are organized into a tribe of their own. Now, the same characteristics of imputation are found, the same ghost theory prevails; but in addition there appear a host of nature ghosts which also take part in the affairs of mankind by assuming the shapes of men and representing them on earth. These new deities play a special role in producing diseases among mankind, and their assistance is invoked to prevent and cure disease.

In a higher stage of culture, when tribes are organized as feudal dependencies about city governments which are ruled by tyrants, and which I have called the monarchical stage of society, there occurs a marked development of the agency of the stars in the affairs of mankind, especially in determining good and evil, and still more especially in determining the state of health and the condition of disease observed on earth. Thus astrology is held to be the ranking science of the world. In this stage diseases are imputed to the stars and to their position, especially at nativity and in other important epochs in the lives of individuals.

Perhaps we have already said enough about the theory of diseases antecedent to scientific medicine. We now must consider briefly the theory of remedies which prevails in the savage, barbaric, and monarchical stages of culture.

In savagery, men find their remedies as they are revealed to them in dreams, ecstasy, hypnotism, intoxication, and even in insanity. In every savage tribe there are particular ceremonies and other means instituted by shamans for the purpose of invoking these aids to diagnosis, and especially of appealing to them for the discovery of remedies. The ceremonies which the medicine-men perform themselves for the discovery of remedies can usually be distinguished from those which they perform over their patients to secure the proper action of their remedies. In the one case ghosts are summoned to reveal the difficulties; in the other case the ghosts are commanded, abjured, begged, threatened, and in various ways induced to leave the body by ceremonial processes. But the shaman, to become such, must first drink his black medicine; he must summon his tutelar ghost by fasting and feasting and by dancing or by long and intense contemplation, by one or another or all of the agencies for opening the portals of ghost-land; and when the gates are ajar he communes with the spirits. Thus medical lore is acquired in these stages of society by dreams, ecstasy, hypnotism, intoxication, and even by insanity.

There are other methods of learning the potency of remedies.

There springs up in savagery a body of occult learning which is a doctrine of signatures, which comes down to the present time. Plants that have red juices act on the blood; plants that have heart-shape leaves act on the heart. In like manner all forms or fancied resemblances of plants and animals have a significance to the shaman as indicative of their medical potency. The world is ransacked to discover these wonderful things which cannot help but reveal their use to the shaman eye.

In early civilization the chemical transmutation of things seems to excite the greatest wonder, which leads to the development of a rude chemistry of transmutation. This new chemistry is alchemy, and the discoveries of astrology are met by the discoveries of alchemy. In this stage of culture, astrology and alchemy prevail as the lore of medical science, which is characterized by the emblems or signatures as they appear in astrology and alchemy. Could we enter into the subject, we could show how the potency of words or the formulæ of expression are now held to be of supreme moment. As poetry is now the fine-art of allegory, so medicine is now the healing art whose lore is taught in allegory. When science comes, the art of medical remedies is emancipated from the art of alchemy, astrology is divorced from diagnosis, and the shaman becomes either a priest on the one hand or a physician on the other. Thus religion and medicine are divorced. But neither religion nor medicine is at once freed from superstition. The progress is slow, and forever there is a war in both departments between science and superstition. How long, oh, how long will it last!

We return now to the consideration of scientific medicine, merely for the purpose of classifying the science, for we are in quest of the evidence by which we desire to exhibit the facts relating to the five properties of matter, and to show that the sciences are legitimately classified by considering the leading properties in a science as the characteristics of that science, and then to see if such classification warrants the conclusion that there are but five properties of matter, and that in every body these five properties appear.

In medicine we are attempting to show thatthe fund amental property on which the science is founded is consciousness, from which are derived the opinions by which physicians serve their fellow men to secure their welfare. We have tried to show that these opinions require a special study of the metabolism, anatomy, physiology, reproduction, and nervous organization of the human being. In addition to this, there is required a special study of the environment of mankind—the environment of air, water, rocks, plants, and animals, including human beings, by which the individual is surrounded. We might have resolved the immediate environment to more remote conditions in the universe, but have contented ourselves with the immediate or proximate environment, rather for the purpose of showing that it is not necessary to make a final resolution of bodies and relations in order to discover pentalogic elements, although such elements appear whether proximate or ultimate conditions are viewed.

The physician must be informed not only about the conditions of health in these realms of environment, but also the conditions of disease in the same realms, in order that he may properly advise his patient for the benefit of his sanitation, or that he may prescribe those remedies which are best adapted to allay the evil effects of his environment. For this purpose he studies the etiology or cause of disease. He must first study the disease itself in its symptoms, and then discover the origin of the disease in unfavorable conditions. We may pass over the study of symptoms, and the classification of diseases themselves, for here we might antagonize contending pathies. Perchance, if I were quite honest, I would confess my inability to treat the subject as a medical expert. Then the physician must be versed in the causes of disease, and he discovers these causes in air, water, rocks, plants, and animals. Now, we might reclassify these agencies of disease, but the discussion would lead us too far from our theme, for we are not writing a medical treatise, and it might lead us too far from our knowledge. Then we are immediately led to the discovery of remedies, and here again we strike upon the pentalogic substances which are employed as remedies, and show how substances, forms, forces, causes, and concepts are employed as remedial agencies. Here again we must stop, lest we enter into disputation and show our ignorance.